The Influence of Group Longevity on Project Communication and Project Performance

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ABSTRACT

This study investigates the communication behaviors and performances of 50 R&D project groups at different stages of group longevity, as measured by the average length of time project members have worked together. Basically, the analyses show that project teams become increasingly insulated from key information areas both within and outside their organizations as their project membership becomes increasingly stable. Such reductions in project communication are also shown to affect adversely the technical performance and innovativeness of project groups. Furthermore, variations in communication activity were more associated with the tenure composition of project teams than with the project tenures of individual engineers. These findings are presented and discussed in the more general terms of what happens in project groups as team membership "ages."

The Influence of Group Longevity on Project Communication and Project Performance

Group and individual member activities do not occur all at once or at a single point in time; they take place over time. One of the major problems in behavioral science research, in general, and in the study of groups and project teams, in particular, has been the general neglect of such temporal issues. Without an appreciation of what happens over time, the question about how well a group is doing will receive an incomplete answer. More temporally-based frameworks are needed, therefore, to conceptualize and analyze the many kinds of changes that are likely to occur within a group as its team membership ages. The research reported here focuses on these issues by examining significant communication and performance differences among 50 R&D project teams whose professional members have been working together for different lengths of time.

Among the more prevalent ideas associated with the study of organizations is the rather broad viewpoint that organizational units try to structure their work environments in a manner that reduces the amount of stress they must face and which is also low in uncertainty (Thompson, 1967; Weick, 1969). According to this argument, groups strive to direct their activities toward a more workable and predictable level of certainty and clarity (Pfeffer, 1981).

Given this perspective, group members interacting over a long period of time are likely to develop standard work patterns that are familiar and comfortable, patterns in which routine and precedent play a relatively large part. Weick (1969) discusses, for example, the strong tendency for groups to establish over time certain stable structures of interlocked behaviors and relationships primarily because they provide certainty and predictability to the interstructured group members. Furthermore, the findings of Katz (1978a, b) suggest that as group members continue to perform their project activities over a long period of time, they may become progressively less responsive to the challenging aspects of their project activities. They may, instead, come to rely more and more on their customary ways of doing things to complete their everyday project requirements. And to the extent that all group members come to share this same general perspective, the more likely they are to reinforce these common views and concerns. Thus, as group members work and share experiences with one another over an extended period of time, i.e., as group longevity increases, they are likely to become increasingly content and ensconced in their familiar routines, interactions, and project responsibilities. Most likely, group members feel comfortable in such stability, for it keeps them feeling secure and confident in what they do.

Group Longevity and Project Communication

Based on such developmental trends, one can easily argue that with higher levels of group longevity, members may gradually become less receptive toward any change, innovation, or information threatening to disrupt significantly their comforable and predictable work practices and patterns of behavior (Staw, 1977; Katz, 1980). The preservation of familiar routines and established arrangements becomes the prime concern. Rather than striving to enlarge the scope of their project activities and information processing requirements, groups with increasingly high amounts of member longevity may become more concerned with extricating or protecting themselves from sources of possible interference, from activities requiring new kinds of attention, or from situations that might reveal their shortcomings.

One of the potential consequences of developing this "status-quo" perspective with increasing group longevity is that groups may become increasingly insulated from outside sources of relevant information and important new ideas (Pelz and Andrews, 1966; Dubin, 1972). Commitment is partly a function of time and as group members become more protective of and committed to their current work habits, interests, and problem-solving approaches, the extent to which they may be willing or even feel they need to expose themselves to new or alternative ideas, suggestions, solution strategies, and constructive criticisms may become progressively less and less. Instead of becoming more vigilant towards their external work environments, they may become increasingly complacent about outside events and new technological developments.[1]

Another set of forces that may diminish the amount of outside contact and interaction for projects with long standing membership is the tendency for group members to communicate only with those whose ideas and viewpoints are in accord with their own current interests, needs, and existing attitudes. One of the most obvious principles of human communication is the strong tendency for individuals to communicate with those who are most like themselves, often referred to as selective exposure (Rogers and Shoemaker, 1971). As group members continue to interact and build a history with one another, it is likely that a more homogeneous set of understandings about the group and its environment will develop through informational social influence (Homans, 1961; Berger and Luckman, 1966; Salancik and Pfeffer, 1978). Group homogeneity can come either from similarity of social backgrounds and characteristics or from group members remaining in their project positions long enough to make shared socialization and shared group experiences a meaningful basis of trust and mutual support (Grusky, 1964; Kanter, 1977). Such shared meanings and awarenesses not only provide group members with a stronger sense of belonging and identity but will also demarcate the group from other entities both within and outside the organization. As a result, a greater degree of homogeneity in knowledge, beliefs, and problem-solving behaviors and approaches is likely to emerge among project members who have been interacting over a long period of time. Such commonalities, in turn, could lead to additional stability in the communication networks and project activities of the group members, resulting in relatively lower levels of outside communication. In short, as the effects of growing complacency, selective exposure, and group homogeneity intensify with high levels of group longevity, and the desire to seek out and actively internalize new or conflicting knowledge and developments may become very slim indeed.

In addition to this possible decay in extra-project communication, it is likely that intraproject communications will also be reduced. As team members work and gain experience with one another, their individual role assignments are likely to become more well-defined and resistant to change. Having worked together in the same project for a long time period, members have probably become increasingly specialized in their particular problem areas and project assignments, resulting in greater role differentiation and less common interaction among all project members (Porter, Lawler, and Hackman, 1975; Katz and Kahn, 1978). As a result, role functions and expectations become clearer with increasing differentiation between leaders and followers, specialists and generalists, those who are competent in a certain technical or problem area and those less so, etc., etc., (Bales, 1955). Gradually, their knowledge of each other's preferences, capabilities, and contributions become more bounded and stable. Members come to know each other well, know what to expect from each other, and consequently, there is simply less need for talk and interaction among all project members. Over time, then, group members tend to create differences among themselves, thereafter, functioning in ways that regularize and stabilize these differences And if members succeed in developing such stabilized roles and perceptions, their overall level of intragroup interaction may decline, causing the group to lose access to much of its internal talent and reducing their total capacity for learning new ideas and innovative patterns from one another.

Despite these possible declines in project communications, organizational units much collect and process information from outside sources in order to keep informed about relevant outside developments as well as new kinds of requirements (Thompson, 1967). Furthermore, the efforts of Allen (1977), Menzel (1966) and many others have consistently shown that oral communications, rather than technical reports, publications, or other formal written media and documentation, are the primary means by which engineering professionals collect and transfer outside information and important new ideas into their project groups.[2]

One explanation for this heavy reliance on personal contact lies in the strong distinction between science and technology (Price, 1965). Unlike the basic sciences in which the cumulative nature of the work is permanently recorded in the formal literature, the direct output of technological work is primarily physical, requiring considerable knowledge of what went into the physical development. As a result, technological documentation is often most useful only when knowledgeable others are directly available to explain and supplement its content. Engineers, therefore, can obtain information either through the very difficult task of decoding physically encoded information or by relying upon direct personal contact and communication with other technologists (Allen, 1977). Their ability to count on the written work is considerably less than that of the basic scientist. Thus, engineering project groups keep abreast of their field and channel new technology and ideas into their work primarily through personal associations with other professionals both within and outside their own organization.

Given the strategic importance of oral communications in organizations, in general, and in R&D project groups, in particular, one must examine explicitly the effects of any forces purporting to influence behavioral contacts within a group and between a project group and its outside technological and work environments. Specifically, the present research investigates the influence of group longevity on the actual levels of interaction among project members and between project groups and their various outside information sources. As a group "ages" and becomes fairly stable in its membership, will its individual team members begin to ignore and become isolated from outside areas of information, influence, and feedback, essentially by communicating less frequently among themselves and with professional colleagues and peers outside their project team?

The Importance of Group Affiliation

One of the more fundamental premises underlying the study of organizations as complex social systems is the notion that group processes play a critical role in determining various behavioral patterns and interactions and in how we construct our situational perspectives (Crozier, 1964; Salancik and Pfeffer, 1978). Ever since the well-known Western Electric studies (Cass and Zimmer, 1975), much of the research in social sciences has been directed toward learning just how powerful group dynamics can be in influencing individual member behaviors, motivations, and attitudes. A substantial portion of the variation in individual communication behavior, therefore, should probably be explainable in terms of group affiliations. In fact, the findings of many studies, including Herman, Dunham, and Hulin (1975) and O'Reilly and Roberts (1975) suggest that group affiliations may provide a better explanation of changes in individual behavior than the characteristics of the individuals. It is hypothesized, as a result, that measures of mean project tenure will account for more of the decay in actual individual communications than individual measures of project tenure.

Project Communication and Performance

Reduced levels of project communication, especially with outside information sources, can be very serious in their consequences, perhaps, even fatal.[3] This may be especially true for R&D groups given their strong dependence on outside ideas and new technological developments in addition to their need for effective coordination with other organizational areas, including manufacturing and marketing (Achilladeles, Jervis, and Robertson, 1971). For example, in developing new product or process ideas, manufacturing requirements and market need information must be combined with both organizational and technical capabilities (Utterback, 1974; von Hippel, 1978). Since project members rarely have all the requisite work-related knowledge and expertise to accomplish their projects successfully, information and consulting support must be gathered from many sources outside the project.

Generally speaking, previous research has consistently shown that R&D project performance is strongly associated with high levels of technical communication by all project members to information sources within the organization (i.e., high levels of internal or intraorganizational communication). The empirical findings of Pelz and Andrews (1966), Allen (1970), and Farris (1972) all strongly support the contention that stimulating direct communications between project group members and other internal information sources can enhance project effectiveness.

More recent findings suggest, however, that not all R&D project groups are alike in the way they function or in the way they should be managed (e.g., Whitley and Frost, 1973; Dewhirst, Arvey, and Brown, 1978). It seems to make a great deal of difference just what sort of work the project group and its members are pursuing. In particular, engineering professionals assigned to more research-oriented projects in an industrial laboratory seem to have very different information needs and consequently behave very differently from engineers concerned with product and process development projects, which in turn are quite different from groups involved in product modification and adaptation, i.e., technical service kinds of activities.[4] Each of these three categories of R&D project tasks requires significantly different patterns of communication for more effective technical performance (Allen, Lee, and Tushman, 1980).

More specifically, it seems that improving the internal contacts and communications of research project members may not be as important for project performance as it is for development and technical service project groups (Allen, Lee, and Tushman, 1980). Development projects, moreover, have been found to be higher performing when group members maintained higher levels of internal communication with individuals from other organizational divisions, especially their clients within marketing and manufacturing (Katz and Tushman, 1979). In general, the performances of development and technical service project groups appear to be positively affected by the amount of direct member communication with relevant internal information sources.

While direct contacts by all project members may be effective for internal communications, the particular methods by which R&D project teams can effectively draw upon technological developments and information outside the organization appear to differ significantly across the research, development, and technical service spectrum of R&D activities (Allen, Tushman, and Lee, 1979; Katz and Tushman, 1980). Although high levels of internal interaction may not be necessary for research groups, their technical performances have been strongly connected to higher frequencies of direct communication by all project members with external professionals outside the organization (Dewhirst, Arvey, and Brown, 1978; Katz and Tushman, 1979). Contrastingly, numerous studies including Allen (1970), Baker, Siegmann, and Rubenstein (1967), and Shilling and Bernard (1964), have consistently shown that development project performance is not positively associated with direct project member communication to external professionals. If anything, they have been found at times to be inversely related.

One explanation for these significant differences stems from the idea that development projects are strongly local in nature in that their problems, strategies, and solutions are defined and operationalized in terms of the particular strengths, interests, and orientations of the organizational subculture in which they are being addressed (Allen, 1977). Development teams in different organizations may face similar problems, yet they define their solution approaches and parameters very differently. The coupling of bureaucratic interests and demands with such localized tasks and language schemes produces a communication boundary that differentiates development projects from important external areas (Lawrence and Lorsch, 1967; Katz and Kahn, 1978). As a result, most development engineers have difficulty communicating effectively with outside professionals and consultants about their project-related activities (Allen, 1977). Research projects, on the other hand, are more universally defined and consequently are probably less influenced and less constrained by localized organizational factors. With less impediment to external communications across organizational boundaries, research project members are able to communicate effectively with external R&D colleagues (Hagstrom, 1965).

This is not to say that external technological developments and information are unimportant for development projects. On the contrary, they are exceedingly important! What is implied by these studies is simply that it becomes increasingly difficult for most development engineers to mesh external ideas, suggestions, and solutions with internal technology that has become more locally defined and constrained.

One way to deal with the difficulties of communicating across differentiated boundaries is through special boundary spanning project members labelled gatekeepers (Allen and Cohen, 1969). With the help of these key individuals, external information can be channelled into development project groups by means of a two-step communication process (Coleman, Katz, and Menzel, 1966). First, gatekeepers gather and understand external information and subsequently translate this information into terms that are meaningful and useful to their more locally constrained colleagues. Gatekeepers, as a result, perform an informal but extremely valuable function, for they are the principal means by which external ideas and information can be effectively transferred into development project groups (Tushman and Katz, 1980).

In similarity with development projects, technical service projects are also more local in nature. Unlike development tasks, however, technical service work tends to deal with more mature technologies, existing knowledge and/or existing products (Rosenbloom and Wolek, 1970; Tushman, 1977). Because these technologies are more stable and can be understood more easily by the organization's management (Frost and Whitley, 1971), the specialized gate-keeper role may not be necessary. Instead, the managerial hierarchy keeps members sufficiently informed about external events and information through formal operating channels (Walsh and Baker, 1972; Tushman and Katz, 1980). Thus, it seems that the method by which external information can be transferred into R&D project groups is strongly contingent on the nature of the project's work.

If project teams communicate less often with both internal and external areas with increasing group longevity, then their overall effectiveness may also begin to suffer. In particular, it is hypothesized that technical performance will be lower when there has been a decline in group communication to those domains requiring direct project member interaction. Accordingly, development and technical service project performances will be lower with decreasing levels of internal communication while research project performance will fall with deteriorating levels of external communication. Lower levels of external communication among members of development and technical service projects will not directly affect project performance since alternative modes of technology and information transfer are more suitable than direct member contacts in these situations. Nevertheless, reduced levels of internal project communication could certainly hinder the emergence of the gatekeeping function and the diffusion of hierarchical information within development and technical service projects respectively.

Group Longevity and Project Performance

Given the critical importance of both internal and external communications for project performance and the possible affects of group longevity on such kinds of project interaction, one should also find a significant relationship between technical performance and group longevity.[5] In fact, three previous studies have shown supporting evidence for this belief. Shepard (1956) was the first to relate performance with group longevity or mean project tenure (calculated by averaging the individual project tenures of all project members). For the small number of R&D groups in his sample, he found that performance increased up to about 16 months average tenure, but thereafter decayed. In another study, Pelz and Andrews (1966) uncovered a similar curvilinear relation between mean group tenure and performance -- the "optimum" group longevity mix occurring slightly below the four year mark. Finally, Smith (1970) was also able to replicate this finding when he showed performance peaking at a mean project tenure of three to four years from a study of 49 R&D groups in an oil firm.

By itself, the idea that project performance may deteriorate with increasing levels of group longevity raises more questions than it answers. Why were the performances of the longer-tenured project groups significantly lower on the average? Are they simply staffed by larger numbers of less able or less motivated engineering professionals, for example, or are there important behavioral variations in how project members actually conduct their day-to-day activities that can help to account for these significant performance differences?

The present study focuses once again on the relationship between group longevity and the overall technical performance of R&D project groups. But this time, the research will examine clearly defined project teams, direct rather than individually aggregated measures of project performance; and most important, it will try to explain any uncovered performance variations in terms of changing levels of project member communications. Thus, if project performance is found to vary curvilinearly with group longevity, then it is hypothesized that project communication to certain internal or external areas will also follow a pattern similar to that of project performance.

METHODOLOGY

Research Setting

This study was carried out at the R&D facility of a large American Corporation. Geographically isolated from the rest of the organization, the facility employed a total of 345 engineering and scientific professionals, all of whom participated in our study. The laboratory's professionals were organized into seven departmental labs which, in turn, were organized into 61 separate project groups or work areas. These project groupings remained stable over the course of the study, and each professional was a member of only one project team, ranging in size from 3 to 15 members. In order to conduct a study involving group longevity, it is critical that all project members be carefully identified and that relevant tenure, age, and communication information be collected from as many project members as possible. One cannot readily rely on sampling techniques to derive group measures. In the present study, a project group was included in our analyses as long as we had appropriate scores of tenure and age from over 75% of all project team members. Complete data was successfully obtained on a total of 50 project groups representing 82% of all projects within this R&D facility. Table 1 presents the means and intercorrelations of the main variables measured in this study.

Insert Table 1 About Here

Technical Communication

To measure actual communications, each professional was asked to keep track (on specially prepared lists) of all other professionals with whom he or she had work-related, oral communication of a given sampling day. These sociometric data were collected on a randomly chosen day each week for 15 weeks. The sampling of days was constrained to allow for equal numbers of weekdays. Respondents were asked to report all oral, work-related contacts both within and outside the laboratory's facility (including whom they talked to and how many times they talked with that person during the day). They were instructed not to report contacts that were strictly social, nor did they report written communications.

These research procedures are similar to those used in other sociometric communication studies, including Allen and Cohen (1969) and Whitley and Frost (1973). During the 15 weeks, the overall response rate was 93 percent. Moreover, 68 percent of all reported communication episodes within the laboratory were reciprocally mentioned by both parties. Given these high rates of response and mutual agreement (see Weiss and Jacobson, 1960 for comparative data), these methods provide a relatively accurate log of the verbal interactions of all professionals within this laboratory.

Project communication is a measure of the average amount of technical communication per person per project over the fifteen weeks. As discussed by Katz and Tushman (1979), six mutually exclusive communication measures were operationalized for each project group as follows:

Internal Communications

1. Intraproject: The amount of communication reported among all project team members.

2. Departmental: The amount of communication reported between the project's members and other R&D professionals within the same functional department.

3. Laboratory: The amount of communication reported between the project's members and R&D professionals outside their functional department but within the R&D facility.

4. Organizational: The amount of communication reported by the project's members with other individuals outside the R&D facility but within other corporate divisions such as marketing and manufacturing.

External Communications

5. Professional: The amount of communication reported by project members with external professionals outside the parent organization including universities, consulting firms, and professional societies.

6. Operational: The amount of communication reported by project members with external operational areas including vendors and suppliers.

Communication measures to these six independent domains were calculated by summing the relevant number of interactions reported during the 15 weeks with appropriate normalizing to adjust for the number of project team members, see Katz and Tushman (1979) for details. Though the overall response rate was extremely high, the raw communications data for incomplete respondents were proportionately adjusted by the number of missing weeks. Finally, none of these six measures of project communication were significantly intercorrelated at the $P<.10$-level of significance with the exception of Departmental and Laboratory communication ($r=.31$; $p<.05$).

Project Performance

Since comparable measures of project performance have yet to be developed across different technologies, a subjective measure, similar to that used by Lawrence and Lorsch (1967), was employed. Each Department Manager (N=7) and Laboratory Director (N=2) was separately interviewed and asked to evaluate the overall technical performance of all projects with which he was technically familiar.[6] They were asked to make their informed judgements based on their knowledge of and experience with the various projects. If they could not make an informed judgement for a particular project, they were asked not to rate the project. Criteria the managers considered (but were not limited to) included: schedule, budget, and cost performance; innovativeness; adaptability; and the ability to cooperate with other parts of the organization. Each project was independently rated by an average of 4.7 managers on a seven-point scale (from very low to very high). As the performance ratings across the nine judges were highly intercorrelated (Spearman-Brown reliability = .81), individual ratings were averaged to yield overall project performance scores.

Project Task Characteristics

In R&D settings, tasks can differ along several dimensions, including time span of feedback, specific vs. general problem-solving orientation, and generation of new knowledge vs. utilization of existing knowledge and experience (Rosenbloom and Wolek, 1970). Based on these dimensions, the following task categories were developed with the help of the laboratory's management:

a. Basic Research: Work of a general nature intended to apply to a broad range of applications or to the development of new knowledge about an area.

b. Applied Research: Work involving basic knowledge for the solution of a particular problem. The creation and evaluation of new concepts or components but not development for operational use.

c. Development: The combination of existing feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. The application of known facts and theory to solve a particular problem through exploratory study, design, and testing of new components or systems.

d. Technical Service: Cost/performance improvement to existing products, processes, or systems. Recombination, modification, and testing for systems using existing knowledge. Opening new markets for existing products.

Using these definitions, respondents were asked to select the category which best characterized the objectives of their project and to indicate, on a three-point scale, how completely the project's objectives were represented by the selected category. The twelve possible answers were scored along a single scale ranging from completely basic research to completely technical service. As in Pelz and Andrews (1966), respondents were also asked to indicate what percentage of their project's work fell into each of the four categories. A weighted average of the percentages was calculated for each respondent (Tushman, 1977). The scored responses of these two questions were then averaged (Spearman-Brown reliability = .91).

By pooling individual members' reponses to obtain project scores, we could readily identify a project as being predominatly either: (1) Research (a combination of basic and applied research categories); (2) Development, or (3) Technical Service. As described by Katz and Tushman (1979), analysis of variance was used to ensure the appropriateness of combining individual perceptions of their activities for the aggregate categorization of each particular project group.

<u>Technological Environment and Project Interdependence</u>

Based on the work of Lawrence and Lorsch (1967) and Duncan (1972), a stable vs. changing dimension of the project's technological environment was investigated. With the help of the senior managers from each department, two general sources of environmentally based change were identified as applicable throughout the laboratory: the rate-of-change of techniques and skills necessary to carry out the task and the rate- of-change within the scientific, technical, or market domains. These two sources were combined to form an overall measure of perceived environmental variability by asking each respondent to answer the following question:

> We are interested in how rapidly you see the demands of your job changing. To what extent are techniques or skills or information needed for your project changing?

A five point scale was used ranging from (1) to a very little extent to (5) to a very great extent.

Project interdependence reflects the extent to which one's project assignments require working with other areas of the organization. As discussed by Tushman (1977), each respondent was asked to indicate (on 10-point scales) the degree to which he or she had to work (1) with other project members; (2) with departmental colleagues outside the project group; and (3) with individuals outside the R&D facility but in other organizational divisions including marketing and manufacturing.

Since projects are the units of analysis, the homogeneity of project members' perceptions of these environmental and interdependent variables were tested to check for the appropriateness of pooling using the same methods described in the previous section of Project Task Characteristics. As pooling was appropriate for each variable, individual responses were combined to obtain project scores.

Tenure and Demographic Data

During the course of this study, demographic data was collected from the laboratory's professionals, including their age, educational degrees, and an estimate of the number of years and months they had been associated with their specific project group and with the overall laboratory facility. As in previous studies (i.e., Shepard, 1956; Pelz and Andrews, 1966; and Smith, 1970), group longevity or mean project tenure was calculated by averaging the project tenures reported by all project members. The mean is used to obtain a representative picture of how long project members have worked together and shared experiences with one another. The mean, however, is only a measure of the central tendency of the project tenure distribution. One must also examine the distribution about the mean.

It is important to recognize, then, that group longevity is not the length of time the project has been in existence, but rather it measures the average length of time project members have interacted with each other. Thus, the measure of group longevity is not tied to project phase nor necessarily related to how long R&D professionals per se have been working in that particular problem area within the company. We should mention, however, that most of the facility's projects were probably of long duration, having been organized around specific, long-term types of problems within areas such as fiber forming development, urethane development, and yarn technology. Finally, measures of mean age and mean organizational tenure were also calculated for each project group by averaging the chronological ages and laboratory tenures reported by all group members.

RESULTS

Project Performance

The 50 projects have group longevity scores ranging from several months to almost 13 years with an overall sample mean of 3.41 years. The mean rating of project performance, as provided by the evaluators, ranged from a low of 3.0 to a high of 6.4 with a mean of 4.59. When project performance was examined as a function of the mean project tenure of team members, there seemed to be some indication that performance was highest in the 2 to 4- year interval, with lower performance scores both before and after.

To get a better idea of whether any distinct pattern might emerge from the relationship between group longevity and project performance, the original performance data were subjected to a smoothing technique using Tukey's (1977) recently developed procedures. These smoothing procedures, as suggested by Tukey, were not used to verify or negate any specific relationship or hypothesis but were employed simply to get a more meaningful picture of the data in order to use more appropriate statistical analyses and comparisons. The resultant calculations, plotted in Figure 1, illustrate very clearly that performance was highest for projects with a mean group tenure of between 2 and 4 years. More interestingly, the shape of these smoothed data points emphasize the possiblity that performance might begin and continue to decline for project teams whose members have averaged five or more years of work in their particular project groups. Clearly, such an exploratory pattern of findings calls for more confirmatory statistical analyses using the original measures of performance and group longevity.

Insert Figure 1 About Here

To corroborate any pattern of significant differences in the distribution of actual project performance scores as a function of group longevity, the fifty groups were divided into a number of different mean project tenure categories. Based on the curvilinear shape displayed in Figure 1, there seemed to be at least 3 different tenure periods represented within the data: (1) 0.0 to 1.5 years; (2) 1.5 to 4.9 years; and (3) 5 or more years. For additional exploratory purposes, the 30 project groups falling within the medium tenure range were equally subdivided into 3 spearate categories as shown in Table 2. The first 0.0 to 1.5-year interval corresponds to the initial learning or building phase previously depicted through the curvilinear performance findings of Shepard (1956), Pelz and Andrews (1966) and Smith (1970). In a similar fashion, the last category of project groups, representing teams whose members have worked together for at least an average of 5 years, corresponds to the low performance interval revealed by these previously cited studies as well as to the time period commonly used to estimate the half-life of technical information (Dubin, 1972).

Insert Table 2 About Here

An examination of the average performance scores of projects within each of the five tenure categories of Table 2 strongly supports the curvilinear association between project performance and mean project tenure within this organization. On the average, performance was significantly lower for project groups whose group longevities were either less than 1.5 years or were more than 5 years. Contrastingly, performance was significantly higher across all three middle tenure categories.

Group Longevity or Mean Age of Project Members?

Almost by definition, projects with higher mean tenure were also staffed by older engineers (r = .47, see Table 1). This raises, of course, the possibility that the performance decay associated with high levels of group longevity had little to do with the team per se. It may have resulted, instead, from the increasing obsolescence of individuals as they aged. Furthermore, a third variable, mean organizational tenure of project members, is also strongly correlated with these two aging type variables and, as a result, should be included in my comparative analysis.

To examine the relative importance of these three variables, successive non-linear regressions were run on project performance to compare the additive effects of each variable after controlling for the effects of the other two. First, the initial row of results in Table 3 confirms the significant curvilinear (concave downward) relationship between project performance and group longevity. The quadratic regression equation containing both mean project tenure and mean project tenure squared accounted for significantly more variance in project performance (Ra=.29) than the simple linear regression containing only mean project tenure (Rc=.16).

Insert Table 3 About Here

A comparative look across the remaining three regression analyses reported in Table 3 demonstrates more convincingly that it is tenure within the project team and not age or organizational tenure that is more likely to influence project performance. As shown by the significant multiple R difference between the 2 regression equations in row b, the addition of the two group longevity terms to the regression already containing the linear and quadratic terms of mean age and mean organizational tenure was still able to explain significant amounts of additional performance data among the 50 project teams. Neither mean age nor mean organizational tenure, on the other hand, showed any further significant association with project performance after controlling for the effects of the other two variables.

Clearly, there are any number of strategies for assigning and rotating individual engineers among project groups. All or nearly all of the team members could be replaced every several years, or members could be changed individually at more frequent intervals. Different strategies such as these could obviously result in markedly different distributions of project tenure within teams even though their overall group longevity scores turn out to be the same. In the organization under study, it is evident that many such strategies were pursued, resulting in a wide variety of distributions of project tenure.

Using the standard deviation of project tenures across team members as one measure of the distribution about the project mean, we explored the relationship between project performance and these variance measures. At first, a distinct curvilinear relation between performance and the standard deviation of project tenure was also uncovered. Closer scrutiny, however, revealed that this significant association probably stemmed from the very high relation between the measures of mean project tenure and their standard deviations (r=.51). As a result, the coefficients of variation were used to reexamine the performance-variance association.[7] Using the previously described smoothing procedures, we could not detect across the 50 projects any clear relation between project performance and this measure of project tenure variance. Nor did any obvious relationship emerge within any of the project tenure categories defined in Table 1. Further research, therefore, is probably needed to explore the effects of different tenure distributions where the relevant variance measures are based on more conceptual criteria such as differences between the individual project tenures of managers and subordinates, newcomers and veterans, or between members of different disciplines or technical specialties.

Project Communication

Having demonstrated a strong association between group longevity and the overall technical performance of the 50 R&D project teams within the current site, we can now examine the various communication factors that might be affecting group performance as team membership ages and stabilizes. It was previously hypothesized that if performance was found to vary with mean project tenure, then technical communications to sources of information outside the project team would follow a similar pattern. More specifically, part of the explanation for any decline in project performance with increasingly high levels of group longevity might be connected with relatively lower levels of interaction with particular internal and external information domains, depending of course on the nature of the project's work. Members of such project groups would essentially be paying less and less attention to outside sources of ideas and information, relying more and more on their own levels of expertise and wisdom.

In order to investigate these possible trends empirically, we tested for significant differences in the actual communication behaviors of the sample's project groups to each of the six communication domains (see Methodology Section) as a function of group longevity. Significant variations were discovered in 3 of the communication domains: Intraproject, Organizational, and External Professional contacts. Communications to the other 3 areas, i.e., Departmental, Laboratory, and Operational, revealed no strong differences among project teams from each of the 5 tenure categories.

Insert Table 4 About Here

Table 4 shows the significant variations in actual communication to the 3 different areas across the 5 categories of group longevity. In support of our hypotheses, contacts outside the project group varied curvilinearly with group longevity in a pattern congruent to that of project performance. Specifically, contacts with individuals from other organizational divisions and contacts with external R&D professionals increased within the initial ranges of mean group tenure, but such contacts become significantly lower as project group membership became progressively more stable. In addition to discussing less of their technical matters with outside individuals from marketing, or manufacturing, or with other professionals outside the organization, members of the high tenured project teams also had significantly fewer interactions amongst themselves. Apparently, there may be some tendency for R&D projects with higher levels of group longevity to become not only more insulated from outside sources of information and influence but also more stabilized in their individual project roles and contributions. To illustrate all of these trends more clearly, Figure 2 displays together the communication and project performance scores as a function of group longevity.

Insert Figure 2 About Here

Group Affiliations

As previously discussed, it was hypothesized that measures of mean project tenure might be more powerful than individual measures of project tenure in accounting for differences in communication behaviors. In support of this argument, we found significantly more variation in the communication behaviors of individuals from groups with very different levels of group longevity than across individuals with differing levels of project tenure. The findings reported in Table 5 demonstrate these effects more convincingly. Specifically, Table 5 shows that the average communication behaviors of individuals with less than 5 years of project tenure were significantly different, depending strongly on whether they were part of a short, medium, or long-term tenured project group. A similar pattern of behavior is also found for the remaining engineers, i.e, those who have been assigned to their projects for 5 or more years. What is also important to note is that, on the average, the communication behaviors of individuals with less than 5 years of project tenure were not significantly different from the communication behaviors of individuals with 5 or more years of project tenure provided they were working in projects with similar levels of group longevity.[8]

Insert Table 5 About Here

Project Performance, Communication, and Group Longevity

Given the significant differences in the internal and external communications of project teams along the group longevity continuum, the remaining question is whether such differences can account for the lower performance ratings of the long-tenured groups. To examine this possibility, regression analyses were used to test for the additive effects of group longevity and group longevity squared after controlling for the effects of project communication. Furthermore, since research, development, and technical service project groups differ significantly in the way they effectively communicate both internally and externally, these regression analyses were run separately for each of the 3 categories of R&D projects.

Insert Table 6 About Here

According to the results reported in Table 6, group longevity did not reveal any additional significant association with project performance after partialling out the effects of the three measures of communication behaviors. There were no significant changes in the multiple R's for either research, development, or technical service projects, although the most important area for project communication did differ significantly across the 3 project categories. These regression analyses, then, suggest that group longevity may affect project performance, at least in part, by operating through reductions in the direct oral communications of all project members to particular information domains.

To gain additional insight into the preceeding regression analyses, Table 7 examines in more detail the inverse part of the relationship between performance and mean project tenure after controlling for the effects of communication by splitting the sample at approximately the median level of group longevity.[9] As shown by the simple correlations

Insert Table 7 About Here

in the first row of Table 7, projects in all 3 categories of R&D activities revealed a significant deterioration in project performance with increasingly high levels of group longevity. With one exception, moreover, the remaining correlations also showed a strong tendency for groups, in each of these project categories, to interact less often with other individuals from the 3 communication domains. For each project type, however, the insulation trend was particularly strong to certain key areas. Specifically, with increasing group longevity, there was an obvious decay in the external professional communication of research project groups, a significant decline in the linkages between development projects and other organizational divisions, and significantly lower levels of intraproject communication for the long-tenured technical service teams.

Finally, the partial correlational analyses in Table 7 are completely in line with previous findings for development and technical service type projects in that reduced levels in the direct external professional communication of all project members did not explain the lower performances of the long-tenured groups. Instead, direct measures of internal communications covaried sufficiently with both performance and mean project tenure to account for their significantly negative association. Unfortunately, there were not enough research projects within our site to test directly the possible effects of less direct external communications on the lower performances of the long-tenured research teams, although the regression findings of Table 6 imply that this is probably the case. Despite this ommission, these analyses clearly suggest the important influence of technical communications in explaining the significant differences in project performance as team membership ages.

Technological Environment and Project Interdependence

One might also conclude from the findings of previous studies, including Allen (1977), Tushman (1977), and Katz and Tushman (1979), that the actual communication patterns of a project team can be significantly affected by how interdependent the project's work is with other organizational areas. Furthermore, the need for keeping abreast of external technological developments through outside professional communication is also probably affected by how fast the relevant technological environment is changing.

Given the significant behavioral differences in communication and performance across the group longevity continuum, it is imperative to examine whether project groups also differed with respect to their perceptions of project interdependence or the changing nature of their technological environment. In checking for this possibility, no significant mean differences emerged for any of these variables across the categories of group longevity either for the sample as a whole or for each type of R&D activity. Thus, members comprising long-tenured project groups interacted less often among themselves, less often with other divisional areas of the company, and less often with outside R&D professionals than members in the medium range of group longevity even though perceptually they were just as interdependent and their technological environments were changing just as rapidly.

DISCUSSION

The thrust of these findings emphasize the important influence of group longevity on changing patterns of information processing and problem-solving activities within project teams as well as the effects of such changes on overall technical performance. In examining performances of project teams within a single R&D facility, a curvilinear relationship was uncovered between these performances and the mean project tenure of group members. This relationship, moreover, was present independent of the actual age of project members or their organizational tenures.[10] Similar performance fluctuations were also found in each category of project work, including research, development, and technical service. Thus, performance appears to be significantly affected by the tenure composition of the particular team currently assigned to the project effort independent of the actual length of time the project per se had been in existence.[11]

The upward slope in performance probably reflects the positive effects of learning and team building as new project members contribute fresh ideas and approaches while they are also developing better understandings of each other's capabilities, better understandings of the involved technologies, better working relationships, etc. Such positive effects, however, appear to have tapered off for teams whose members have continued to work together for a long period of time. Decays in the performances of long-tenured project teams were uncovered in all three areas of R&D effort, i.e., research, development and technical service.

Certainly it is possible that, on the average, the long-tenured project groups had come to be staffed by less technically competent or perhaps less motivated engineers and scientists, although the average project tenure of supervisors from the 10 long-tenured teams did not significantly differ from the average project tenure of supervisors from the 30 projects within the medium range of group longevity. Nor were there any significant differences in overall educational levels, technical reports written, or in the number of professionally sponsored journals read (at least on a self-report basis).

More importantly, recent follow-up visits to this facility show that the same proportion of professionals from both the long and medium tenured project teams had been promoted to higher level managerial positions above the project leadership level during the five year interval since the collection of our original data. 15% of the engineers who had been working on projects with group longevity scores between 1.5 and 5.0 years attained managerial positions of either laboratory supervisor or laboratory manager while the comparable percentage for engineers who had been working in the 10 projects with mean group tenure scores of at least 5 years was 13%. In addition to such managerial advances, about 2 1/2 years after our data collection, a dual ladder promotional system was introduced, according to the company, to reward individual professionals whose "technical competency and contributions are well-recognized." 12% of the engineers who had worked within the medium-tenured project teams were promoted above the project leadership level to positions on the technical side of this dual ladder. Surprisingly enough, the comparable percentage for the long-tenured teams was slightly higher, roughly 19%. Such post-promotional histories strongly imply that neither individual competency nor perhaps the importance or visibility of the project work to the organization can account for the significant difference in technical performance between medium and long-tenured project groups.

As hypothesized, what was able to account for these performance differences were clear reductions in the direct communications of all project members to certain key information domains. For projects whose group memberships had become increasingly stable over time, team members were communicating less often amongst themselves, less often with individuals from other organizational divisions, and less often with external professionals from the larger R&D community. Since the discussion and transfer of technical information and new ideas is an important component of effective project performance in R&D settings, it seems reasonable to attribute, at least in part, the the lower technical performances of long-tenured groups to these behavioral differences in information processing activity.

One should also emphasize that it is not a reduction in project communication per se that leads to a deterioration in overall performance. Indeed, some of the measures of project communication did not diminish significantly with higher levels of mean project tenure. Rather a decline in performance is more likely to stem from a group's tendency to become increasingly isolated from sources that provide the most demanding kinds of evaluation, suggestions, and feedback. Sources, that is, that are likely to provide information, ideas, and task requirements that are most challenging and threatening to the group's current practices, commitments, and beliefs, Since research, development, and technical service projects differ significantly in these information sources as well as in the methods by which such information can be effectively gathered and processed, projects within each of these work areas are likely to suffer more when there is widespread insulation from its most critical information domains. Thus, performance may decline when research members fail to pay sufficient attention to events and information within their external R&D community or when development and technical service project members fail to communicate directly and adequately with their internal peers or internal client groups from marketing and manufacturing.

As previously discussed, development project performance is more sensitive to the presence of technical gatekeepers than to the level of interaction by all project members with external professionals. While lower amounts of external contact did not affect directly the performances of development groups, lower levels of project communication in general could have affected the extent to which gatekeeping individuals were able to emerge or be utilized internally. Although this issue cannot really be answered with the present data base, it is worth noting that none of the 5 development teams with group longevities of at least 5 years had a technical gatekeeper as part of their project membership.[12] These groups, therefore, either did not have a member capable of fulfilling this gatekeeping role or technical gatekeepers could no longer function this capacity once the internal and external communication patterns of the group diminished. From a managerial viewpoint, it would be extremely important to determine whether gatekeepers could maintain their strong internal and external contacts in the face of declining project communications by other group members, and if so, whether their continued presence could sustain high project performance. In addition, it could be important to determine the effects of assigning technical gatekeepers to long-tenured development groups. Would such an assignment enhance performance through increased communication, or would group members collude to ignore the suggestions and contributions of such individuals? While we have learned a great deal about the importance of the gatekeeping and other critical role functions for product and process innovations (Allen, 1977; Katz and Tushman, 1980; Roberts, 1980), we need to learn considerably more about how these roles evolve as well as how they are affected by increasing stability in both group and laboratory memberships.

Group Affiliations

What is also important to recognize from this study is that communication behaviors of engineers in comparable tenured groupings were more similar to the behaviors of their fellow team members than to the communication patterns of engineers working in different tenured groupings. In the current laboratory, for example, there were no clear trends in any of the communication activities of individual engineers when examined as a function of project tenure. Only when the engineers were grouped according to their project affiliations were there clear and obvious decreases in communication as a function of high levels of group longevity. Engineers with high levels of project longevity, therefore, did not have significantly lower amounts of communication as long as they were not part of a long-tenured project group. In contrast to individual type explanations, such findings strongly support the important influence of the social context in mediating individual behaviors and activities. While many other studies have shown the direct affects of the social environment on job attitudes and perceptions, few studies have demonstrated such effects on work-related behaviors.

The fact that communication behaviors were more associated with group characteristics than individual ones underscores the argument that perceptions and responses do not take place in a social vacuum but develop through successive encounters with work environments (Katz and Van Maanen, 1977; Salancik and Pfeffer, 1978). Behaviors and reactions, therefore , are not invariant but change over time as employees continue to interact with various aspects of their job and organizational surroundings. Thus, one must carefully consider the situational context in which project activities are being carried out in order to understand more fully how group members define and interpret their work experiences and to gain a more complete picture of group behavior.

The behavioral patterns reported in this study support the point of view that over time members of long-tenured groups come to share a more common set of beliefs about their work settings. Burke and Bennis (1961), for example, demonstrated from their longitudinal research that as group members continued to interact, there was a strong tendency for them to increase their consensus with one another, essentially moving towards greater perceptual congruity. Thus, it is likely that as project members continue to work together over a long time period, they will continue to reinforce their common views, commitments, and problem-solving strategies. Such shared perceptions created through group processes act as a powerful situational constraint on individual attitudes and behaviors, similar to the structural effects discussed by Blau (1960). These homogeneous tendencies, then, not only insulate the group from outside sources but also provide a great deal of assurance to group members. Given the certainty they facilitate, it is understandable why shared systems of meanings and beliefs come to have great stability and resistance to change.

In particular, the way engineering project groups come to view their outside work environments can be very critical. Given the relatively low levels of external professional communication for the long-tenured project groups, for example, members may have reached consensus concerning the relevance and usefulness (or lack thereof) of outside technological developments. Project groups with increasingly stable memberships may have developed and strengthened their belief that they possess sufficient expertise and knowledge in their specialized areas of technology that it is not necessary to consider very seriously the possibility that outsiders might have produced important new ideas or information relevant to the accomplishment of their tasks. Rather than face the anxiety and discomfort inherent in learning or change, they assume their ideas, strategies, and know-how are far superior to competitive alternatives coming from outside their group. This perceptual outlook has come to be known in the R&D community as the "Not Invented Here" or NIH Syndrome. According to this viewpoint, competing groups are so far behind they could not possibly produce anything that might be very important.

Regardless of whether such an attitude is warranted, as project groups with increasing group longevity come to view outside ideas and information more competitively and reinforce each other in such a belief system, the less contact they are likely to have or will want to have with such outside information sources. Not only are they likely to search and monitor their external technological environments less often, but they are also likely to bias adversely their views and evaluations of any seemingly competitive ideas, innovations, or products stemming from sources outside their own group. And as in any system of intergroup competition, groups develop their own sets of illusions, seeing only the virtue and superiority of their own activities while viewing the competition as inferior and weak, thus, ensuring visions of their own invulnerability (Alderfer, 1977). Furthermore, the more insulated a project group becomes from its competition, the more stereotyped such outside groups will become in the eyes of project team members, eventually coming to view all of them as one large inept entity (Katz and Kahn, 1978).

The findings within the present site clearly lend support to this NIH Syndrome for long-tenured project groups. Manufacturing and marketing groups, moreover, are also typically in competitive conflict with their R&D counterparts in either product development or technical support kinds of activities. Consequently, reductions in communication with these organizational areas by long-tenured development and technical service groups are also consistent with the NIH arguments. What is suggested by these results, then is that communication patterns of project team members and their subsequent effects on project performance might be strongly influenced and managed through staffing decisions. One would argue, for example, that the energizing and destabilizing function of new members should help prevent a project group from developing interactions and behaviors characteristic of the NIH Syndrome.

Whether project groups can circumvent the NIH Syndrome without some rejuvenation from new team members is an important question that needs to be addressed. In the present R&D facility, none of the 10 long-tenured projects was among the facility's higher performing groups. All 10 teams were rated as either average or below average in performance. As a result, we cannot determine from the present sample if high performing long-tenured project groups were somehow able to maintain appropriate patterns of communication and interaction with their more critical areas. Additional research from other facilities is obviously needed to ascertain just how deterministic the current findings are with respect to project performance, group longevity, and project communications. Different patterns, for example, might emerge with different kinds of organizational structures. A facility organized around some type of matrix structure might sustain the effectiveness of long-tenured project groups provided their members remained strongly linked to their functional or technical specialty groups. In a general sense, then, we need to consider the different kinds of trends and changes that are likely to take place within a group as its team memberships ages, and just as important, we need to uncover the kinds of tasks, structures, and practices that are likely to prove useful in keeping a project group innovative and high performing as its members continue to work together.

Future Directions

In this paper, we have discussed only a few of the factors that might be important in seeking an answer to our originally posed question of how is the group doing. One must be careful, however, in interpreting the reported data patterns, for they are based only on cross-sectional data. As a result, one cannot really be sure of what happens to a project group as its members interact over a long period of time. Strictly speaking, one can only speculate about the tendencies for project performance and communication behaviors to decline with increasingly high levels of group longevity. Longitudinal studies are clearly needed to corroborate the situation.

Communication patterns, of course, are only one of a large number of possible behavioral and perceptual changes that need to be investigated as a function of group longevity. For example, with increasing stability in membership, projects may become progressively biased about their own task procedures and solution strategies as well as increasingly narrow in their range of cognitive abilities.[13] In a similar vein, there may develop strong tendencies to acquire (and attact as well) only project members that are most likely to "fit-in", i.e., project members with similar beliefs and interests. Such homogeneous tendencies suggest even less diversity and more narrowly defined interests, capabilities, and specializations which might inhibit further group creativity and innovativeness.

These are just some of the issues that need to be addressed if we are to build more useful and realistic frameworks for diagnosing group developments. Yet, in a more general sense, the challenge to the understanding, managing, and staffing of on-going project teams probably lies in the ability to maintain stability and continuity within the group yet retain sufficient flexibility to keep abreast of external developments in order to detect and internalize relevant changes and advancements. Thus, it is in the knowledge of how to organize and manage between adaptation and adaptability that we need to learn so much more!

FOOTNOTES

1. One must also realize that under these kinds of circumstances, any outside information that is processed by such groups may not be viewed in the most open and unbiased fashion. Janis and Mann (1977), for example, discuss at great length the many cognitive defenses and distortions commonly used to support, maintain, and protect particular decisional policies and strategies.

2. In a "real-time" study of 17 engineering project teams, for example, Allen (1977) carefully demonstrated that only about 11% of all the idea generating "messages" were obtained through the technical literature or through other written or documented means. Nearly all of the remaining messages occurred through interpersonal communications.

3. The extent to which increased isolation may be a severe problem depends considerably on the nature of the team's work. For example, groups working on fairly routine, simple tasks in a relatively stable technological environment may not necessarily suffer as a result of less external vigilance, for internal expertise and experience may be sufficient -- at least for as long as the relevant technology remains of prime importance. Generally speaking, as groups function in a more rapidly changing technological environment and work on more complex tasks requiring greater levels of creativity and innovativeness, the effects of increased insulation are more likely to be dysfunctional.

4. Specific definitions of these project categories can be found in the Methodology Section.

5. The argument that group longevity affects performance through project communication rests on the assumption that communication directly influences performance. While the opposite is also probably valid, there has been considerable longitudinal research demonstrating strong positive effects of communication on technical performance (See Allen, 1977, for a review).

6. It is important to mention that in making these informed judgements, higher level managers were not cued regarding the purpose of this study. Furthermore, post-study conversations have revealed that none of the managers could easily identify projects with relatively higher levels of group longevity.

7. Since individual project tenures are unlikely to be normally distributed within a project, the coefficient of variation is not without its problems. As a result, other types of intragroup measures could be employed. The most promising measures would probably entail some kind of clustering or modal analysis to distinguish between distributions that are unimodal, biomodal, etc. Such measures, however, are extremely hard to compare across projects of different sizes and are also extremely sensitive to any particular cutoff parameters that need to be defined. Given these potential diffi-

culties as well as the robustness of our metric techniques vis-a-vis the normal distribution, variance parameters defined around a normal distribution, including the standard deviation, the coefficient of variation, the skew coefficient, and kurtosis, still seem most appropriate. In the present study, all of these measures were used to explore the performance-variance relationship but without any additional success.

8. The results in Table 5 are based on an individual cutoff tenure of 5 years. There is nothing sacred about this particular separation other than it coincides nicely with the categorization of long-tenured project groups. Parallel analyses conducted at other individual cutoff points yielded results extremely similar to those reported in Table 5.

9. The median level of group longevity was 2.60 years. However, since 5 project groups clustered extremely close to this median level, the sample was actually split at 2.50 years in order to increase the sample sizes in the analyses.

10. This result is particularly important in light of the many suppositions regarding the general decline of technical performance as engineers age and become increasingly obsolete sometime after their mid-thirties.

11. From a historical perspective, individuals may have been working in a particular project or work area for a long period of time, but the collection of technologists currently assigned to the project could fall anywhere along the group longevity continuum. Development work on a flat T.V. picture tube, for example, has been going on for over 25 years in one electronics company but the team currently assigned to this effort has an average project tenure of only 2.3 years. Clearly, the behaviors and performance of any given project group are probably also affected by the particular phase of the project whether it be in preliminary design, laboratory testing, or product transfer. While we could not control or test for the importance of project phase in the current study, future research might address the possible interactions between group longevity and project phase.

12. See Tushman and Katz (1980), for a discussion and operational definition of the gatekeeper concept.

13. Staw and Ross (1978) have recently illustrated, for instance, that individuals were likely to escalate their commitments towards their solution strategies even in the face of adverse information as long as they felt responsible and involved in the undertaking of such strategies.

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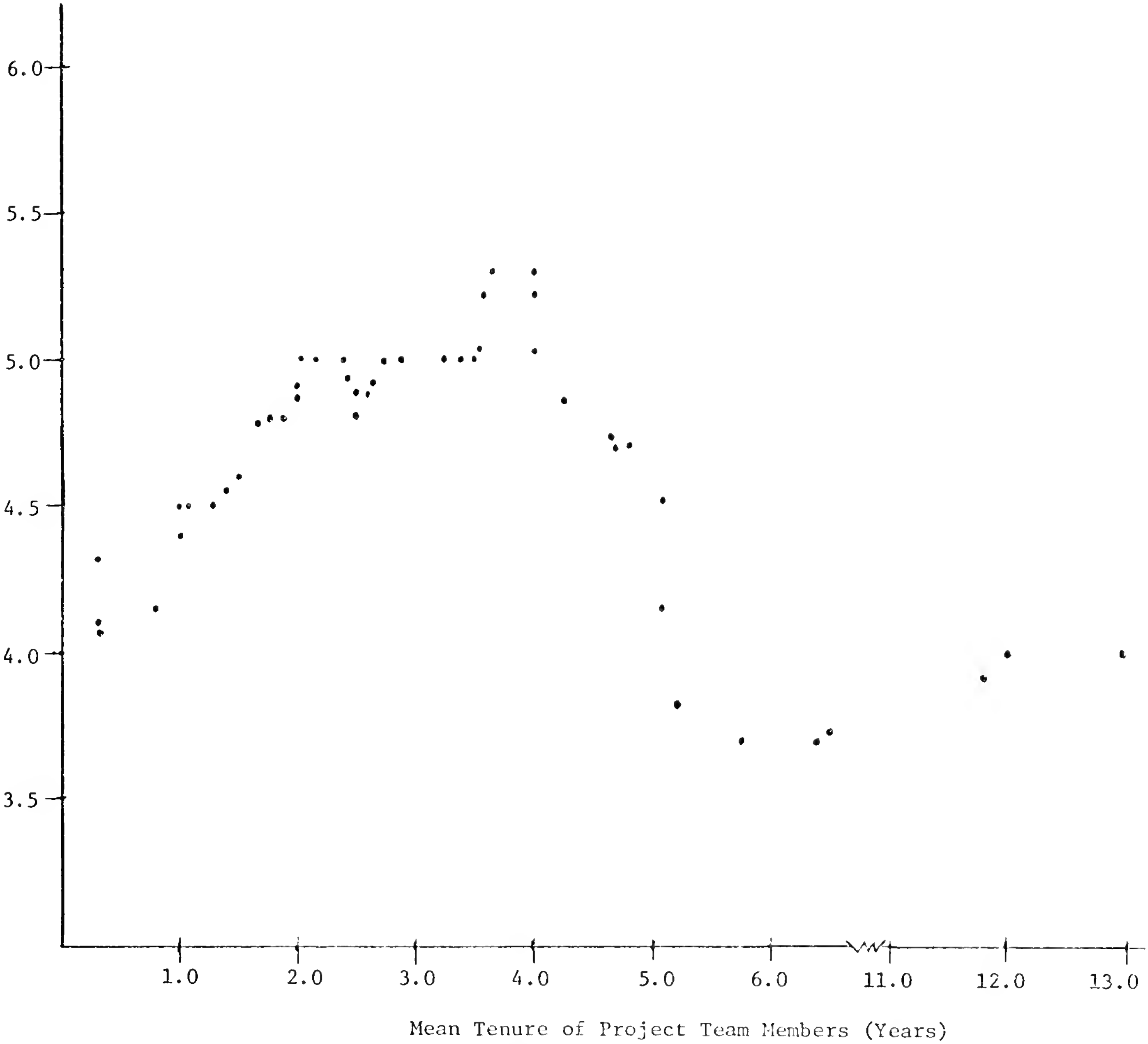

FIGURE 1. Smoothed Project Performance as a Function of the Mean Tenure of Project Team Members

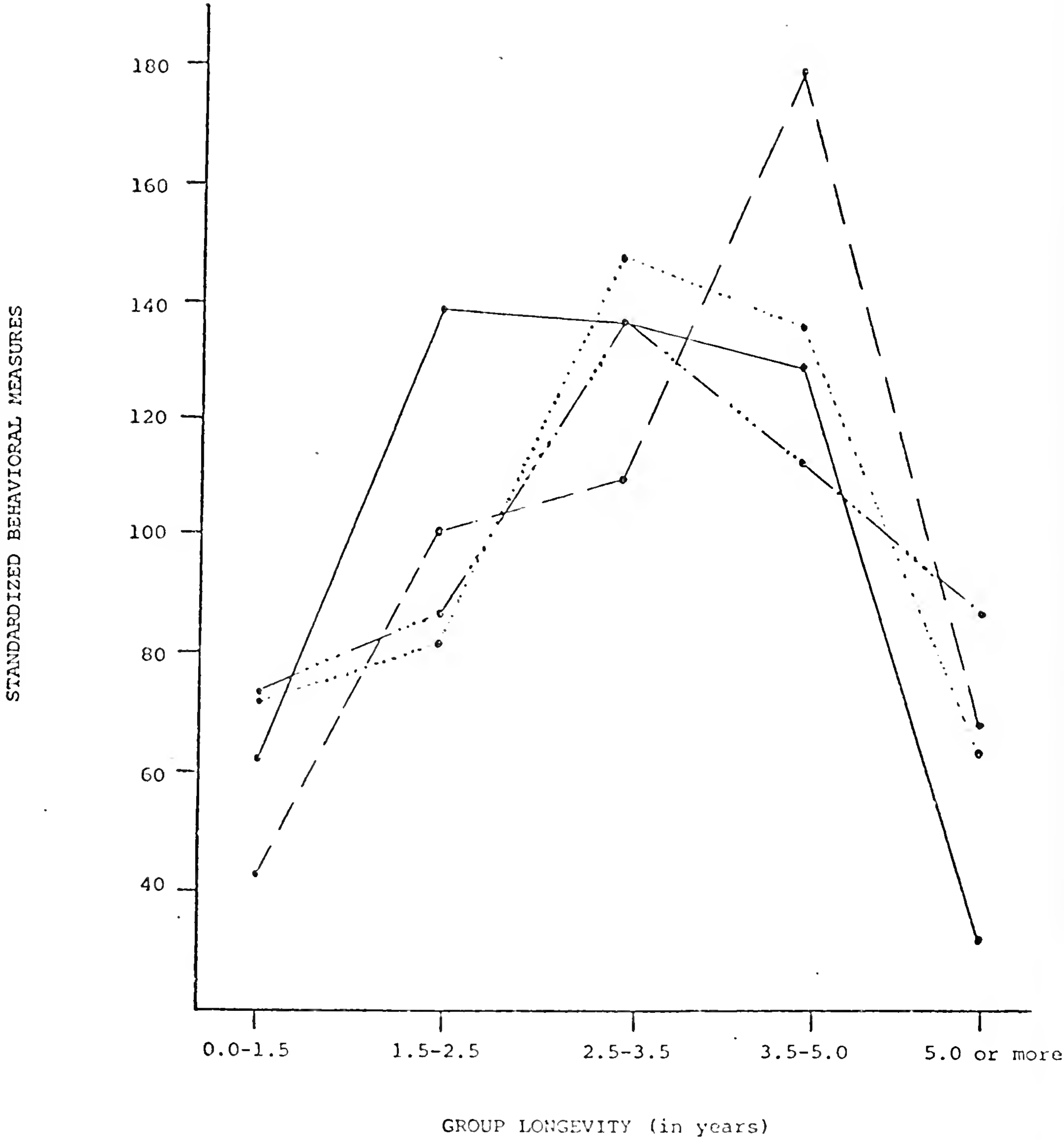

Figure 2. Standardized Performance and Communication Means By Group Longevity

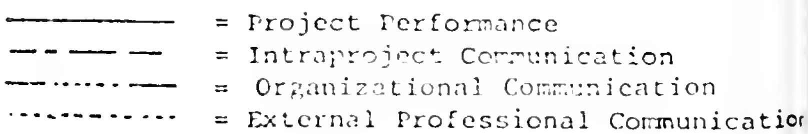

TABLE I. Variable Means and Intercorrelations

Variables	Intercorrelations 1	2	3	4	5	6	7	8	9	10	11
1. Intraproject communication	1.00										
2. Departmental Communication	.12	1.00									
3. Laboratory Communication	-.06	.31	1.00								
4. Organizational Communication	.10	.05	-.13	1.00							
5. Professional Communication	.18	.05	.07	-.07	1.00						
6. Operational Communication	-.03	-.07	-.13	.17	.00	1.00					
7. Project Performance	.11	-.17	-.10	.14	-.06	-.12	1.00				
8. Group Longevity	-.14	.10	-.06	-.13	-.14	.12	-.16	1.00			
9. Mean Project Age	-.10	.01	.11	-.07	-.20	.15	-.17	.47	1.00		
10. Mean Organizational Tenure	-.11	.11	.15	-.03	-.14	-.06	-.13	.61	.65	1.00	
11. Project Size	.23	-.03	-.15	-.07	.20	-.14	.06	-.09	-.02	-.07	1.00
Mean	45.4	17.3	10.4	22.8	1.27	4.61	4.59	3.41	38.0	7.04	6.46

Note: With an N of 50 projects, a correlation of 0.24 is significant at the .05-level.

TABLE 2. Project Performance as a Function of Group Longevity

	Categories of Group Longevity (in years)					All Project Groups
	0.0-1.5	1.5-2.5	2.5-3.5	3.5-5.0	5.0 or more	
Mean Project Performance**	4.29	4.89	4.87	4.82	4.07	4.59
Standard Deviations	0.99	0.67	0.70	0.59	0.52	0.76
No. of Projects	10	10	10	10	10	50

** Based on a 1-way ANOVA test, the mean project performance scores are significantly different across the five group longevity categories [$F(4,45)=2.89$; $p<.05$].

TABLE 3. Comparison of Multiple Regressions on Project Performance by Mean Project Tenure, Mean Age and Mean Organizational Tenure

Control Variables in Regression Equation Rc	Variables Added to Regression Equation Ra	Multiple Correlations With Performance Rc	Ra	F-Value (Ra-Rc)
a) Rc = R mean project tenure	Ra = Rmp	.16	.29	3.01*
b) Rc = Rmo + ma	Ra = Rc + mp	.24	.39	2.48*
c) Rc = Rmo + mp	Ra = Rc + ma	.32	.39	1.52
d) Rc = Rmp + ma	Ra = Rc + mo	.36	.39	0.86

Note: In testing for significant additive differences between Rc and Ra (*$p < .10$; N = 50), the following definitions are used:

1) ma = mean age of project members + mean age squared
2) mp = mean project tenure of project members + mean project tenure squared
3) mo = mean organizational tenure of project members + mean organizational tenure squared

TABLE 4. Mean Communication Frequencies as a Function of Group Longevity

Areas of Communication	Categories of Group Longevity (in years) 0.0-1.5	1.5-2.5	2.5-3.5	3.5-5.0	5.0 or more	All Project Groups
Mean Intraproject Communications**	42.0	101.0	110.0	180.0	69.0	100.0
Mean Organizational Communications* (per person per month)	17.5	20.3	30.0	25.6	20.4	22.8
Mean External Professional Communications* (per person per month)	0.81	0.98	2.04	1.83	0.69	1.27
No. of Projects	10	10	10	10	10	50

A 1-way ANOVA test was used to test for significant mean difference across the five group longevity categories (*$p<.10$; **$p<.05$)

Note 1. Because intraproject communication frequencies had to be adjusted for the number of possible interactions (see Katz and Tushman, 1979), intraproject communication scores can not be linked to an absolute scale. To show relative intraproject differences across the various categories, however, the intraproject measures have been standardized to an overall sample mean of one hundred.

TABLE 8. Multiple Regressions on Project Performance by Group Longevity Terms After Controlling for Project Communication

Project Type	Communication Variables Controlled for in Regression Equation "Rc"	Multiple Correlations: Rc	Multiple Correlations: After Adding Group Longevity Terms Ra	F-Value (Ra-Rc)
RESEARCH: (N = 12)	Intraproject Organizational External Professional**	.61	.65	0.26 (N.S.)
DEVELOPMENT: (N = 21)	Intraproject Organizational** External Professional	.47	.58	1.31 (N.S.)
TECHNICAL SERVICE: (N = 17)	Intraproject* Organizational External Professional	.38	.56	1.36 (N.S.)

*$p < .10$ and **$p < .05$ indicate communication variables with significant regression coefficients

N.S. = No significant difference in project performance after adding group longevity plus group longevity squared.

TABLE 6. Mean Communication Scores of Engineers By Individual and Group Longevities

Communication Variables:	PROJECT TENURE of Engineer:	Engineer is member of a project team with a MEAN GROUP LONGEVITY score of:		
		<1.5 yrs.	1.5-5.0 yrs.	≥5.0 yrs.
Intraproject Communication	a) less than 5 years***	29.5	47.1	28.0
	(N=)	(46)	(133)	(18)
	b) 5 or more years**	35.1	58.2	32.7
	(N=)	(6)	(48)	(30)
Organizational Communication	a) less than 5 years**	12.3	18.6	6.4
	b) 5 or more years**	7.1	24.3	14.2
External Professional Communication	a) less than 5 years	0.7	1.3	0.8
	b) 5 or more years**	0.1	2.0	0.4

Note: Based on ANOVA analyses, there were significant mean differences in the communication behaviors of engineers <u>across</u> the group longevity categories (*$p<.10$; **$p<.05$; ***$p<.01$). Contrastingly, there were no significant mean differences <u>within</u> group longevity categories for any of the communication variables.

TABLE 7. Partial Correlations Between Group Longevity and Project Performance and Communication for Projects with Mean Tenure of at Least 2.5 Years

Variables Correlated With Group Longevity	Project Type: Research (N = 6)	Development (N = 12)	Technical Service (N = 12)
CORRELATIONS:			
a) Project Performance	-.62*	-.39*	-.44*
Internal Communications			
b) Intraproject Communication	-.26	-.14	-.72***
c) Organizational Communication	.27	-.53**	-.12
External Communications			
d) External Professional Communication	-.51	-.23	-.38
PARTIAL CORRELATIONS:			
a) Project Performance Controlling for Internal Communications	I	-.19	-.13
b) Project Performance Controlling for External Communications	I	-.42*	-.36

*p<.10; **p<.05; ***p<.01

I = Insufficient number of projects for partial analyses.

Date Due

[redacted]	MAR 30 1990	
DEC 7 1984		
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